UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
Resource Assessment and Conservation
Engineering Division
7600 Sand Point Way Northeast
BIN C15700, Building 4
Seattle, Washington 98115-0070

August 3, 1989

CRUISE RESULTS
NOAA SHIP MILLER FREEMAN
Cruise No. 89-01

Echo Integration/Midwater Trawl Survey of Spawning Pollock
in the Aleutian Basin and Bering Sea Shelf

CRUISE PERIOD, AREA, AND SCHEDULE

After initial tests and calibration of the acoustic system in Puget Sound, the NOAA Ship Miller Freeman departed Seattle on January 7, 1989, en route to Kodiak, Alaska. After a touch and go in Kodiak on January 14 to embark scientists, the vessel proceeded to the Aleutian Basin to begin operations. Survey operations commenced on January 17 and were completed on March 9. The vessel's itinerary was as follows:

January 5	Depart Pacific Marine Center (PMC) and transit to Pier 36.
January 5-6	Calibration of acoustic system and midwater trawl tests.
January 7-14	Transit to Kodiak; embark scientists.
January 15-17	Transit to Makushin Bay; rendezvous with Japanese R/V Kaiyo Maru.
January 17-19	Leg 1. Standard sphere calibration of acoustic system in Makushin Bay.
January 20-February 8	Echo integration/midwater trawl survey of western Aleutian Basin and preliminary survey of pollock in the vicinity of Bogoslof Island.

February 9-11	In port, Dutch Harbor; exchange scientists.
February 12	Leg 2. Acoustic system intercalibration with Kaiyo Maru.
February 13-14	Standard sphere calibration in Makushin Bay.
February 15-March 1	Echo integration/midwater trawl survey of eastern Aleutian Basin and Bering Sea shelf.
March 1-7	Resurvey of Bogoslof Island area.
March 8	Standard sphere calibration in Makushin Bay.

OBJECTIVES

This survey was a cooperative effort on the part of the Far Seas Fisheries Research Laboratory (FSFRL) of Japan and the Alaska Fisheries Science Center (AFSC) to assess the spawning biomass of walleye pollock (Theragra chalcogramma) in the eastern Bering Sea. The principal objectives were to:

1. Collect echo integrator and midwater trawl data necessary to determine the distribution, biomass, and biological composition of spawning pollock in selected portions of the Aleutian Basin, including the area outside the U.S. Fishery Conservation Zone (donut hole), the area near Bogoslof Island, and the Bering Sea shelf.

2. Conduct an intercalibration of acoustic systems aboard the Miller Freeman and the Kaiyo Maru.

3. Collect measurements of a standard sphere to provide calibration information about the acoustic system and to detect changes in system performance with changes in transducer depth.

4. Collect biological samples of pollock for reproductive and stock structure studies.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

The survey was completed on board the NOAA Ship Miller Freeman, a 66 m stern trawler equipped for fisheries and oceanographic

research. The acoustic system used during this cruise was an echo integration and target strength measurement system operating at 38 kHz. The transducer, housed in a dead-weight fin, was towed at approximately 15 m below the surface. System electronics were housed in a van mounted to the weather deck of the vessel. Echo data were processed using a Hewlett Packard 1000 computer.

Echo sign was sampled using a modified Northern Gold 1200 midwater rope trawl (NET Systems, Inc.). The trawl, which had ropes in the forward section and mesh sizes ranging from 64 inch (163 cm) forward to 3.5 inch (8.9 cm) in the cod end, was outfitted in a bridle-less configuration, with 5 m^2 doors, 455 kg tom weights, and a 1-1/4 inch (3.125 cm) mesh cod end liner. Trawl mouth opening and depth were monitored with a third-wire netsounder system mounted to the headrope of the trawl. The vertical net opening ranged from 12 to 23 fm (22 to 42 m) with an average of 17 fm (31 m).

Water temperature/conductivity profile data were collected at each trawl site and other selected locations using a Seabird CTD system. Additional information was obtained by deploying XBTs. Surface temperatures were measured with a bucket thermometer.

SURVEY METHODS

Calibration of the acoustic system using the University of Washington's calibration barge was carried out on January 5 and 6 at Pier 36 in Seattle. This calibration provided measurements of system parameters used to scale echo integrator outputs to estimates of absolute fish abundance.

The standard sphere calibrations were conducted in Makushin Bay with the vessel anchored fore and aft in approximately 100 m of water. This calibration involved suspending a copper sphere with known acoustic properties below the fin and lowering the fin through the water column to determine changes in system performance with transducer depth. Acoustic data were collected with the transducer positioned at selected depths between 2 and 30 m.

Survey tracklines in the western Aleutian Basin consisted of parallel transects spaced 80 nmi apart and oriented in a north-south direction. East of St. Paul Island, transect spacing was reduced to 40 nmi. On the shelf north of Unimak Island, transect spacing was further reduced to 20 nmi. At the end of Leg 1, a few days were spent surveying an area between Bogoslof Island and the Islands of Four Mountains to collect information on size and maturity of pre-spawning pollock. After completion of the large

scale basin/shelf survey, a more detailed survey of the Bogoslof Island region was conducted. Transects were spaced 10 nmi apart and extended north from the Aleutian Islands chain approximately 40 nmi.

Survey operations were conducted 24 hours a day. Vessel speed varied between 5 and 12 knots, depending upon weather conditions. Echo integrator density estimates were computed at 1 minute intervals for each 1 m depth stratum between the transducer and the bottom. These 1 m values were summed over the water column to provide estimates of surface density (kg/m^2).

Midwater trawl hauls were made at selected locations to identify echo sign and provide biological samples. The average trawling speed was about 3 knots. Standard catch sorting and biological sampling procedures were used to provide estimates of weight and number by species for each haul. Walleye pollock were further sampled to determine sex, length, weight, age, maturity, ovary weight, and stomach composition. Other pollock samples were preserved for genetic and morphometric/meristic studies to examine stock structure.

Intercalibration of the acoustic system aboard the Miller Freeman with the Kaiyu Maru's acoustic system took place 25 nmi southwest of Bogoslof Island. The two vessels made 15 transects over a school of fish approximately 4 nmi long with the Kaiyo Maru 0.25 nmi to port and 45° astern of the Miller Freeman.

PRELIMINARY RESULTS

Standard sphere calibrations

Three standard sphere calibrations were conducted during this cruise. The first calibration, January 17-19, was plagued with equipment problems. The second, February 13-14, was hampered by a swinging moorage due to weather. The third calibration, March 8, was conducted in ideal weather conditions. During winter, very few fish reside in Makushin Bay; thus, fish did not interfere with the data collection. Preliminary results from the second calibration indicated a factor of two increase in total system sensitivity with increasing depth when the transducer is lowered from 2 m down to 30 m (Fig. 1). Most of the observed sensitivity increase occurred at depths greater than 10 m. Between 2 m and 10 m, target strength measurements were relatively stable. During transducer ascent, target strength measurements seemed to lag behind those observed during descent, indicating historesis in the transducer.

Acoustic system intercalibration

An intercalibration of the acoustic system aboard the Kaiyo Maru with the AFSC system aboard the Miller Freeman was attempted in Bering Sea shelf waters on January 20. Bad weather and rough seas halted operations after only 2 hours of data collection. On February 12, a second intercalibration attempt was made in better weather conditions and 15 hours of echo integration data were collected. During the February 12 intercalibration, a school of pollock approximately 4 nmi long and at a depth of 325-450 m was located 25 nmi southwest of Bogoslof Island. Fifteen replicate transects were made over the school. An additional intercalibration attempt on the shelf on February 25 was foiled when neither vessel was able to locate suitable fish sign. The scheduled intercalibration with the two vessels at anchor in Makushin Bay on February 28 was cancelled when the Kaiyo Maru reported no fish sign in the bay.

Biological and oceanographic data

A total of 27 midwater trawl hauls were made during the cruise (Table 1). Pollock was the most abundant species by numbers (and by weight) encountered in trawl catches (Table 2). Biological data collected for pollock include more than 7,000 length measurements, over 2,000 pairs of otoliths, numerous maturity stage assessments, weights, stock structure data, and stomach content data (Table 3). A total of 44 CTD casts (Table 4) and 43 XBT casts (Table 5) were taken.

Leg 1

Aleutian Basin/Bering Sea Shelf Survey

The first few days of Leg 1 were plagued by terrible weather and equipment failures. A serious problem with the transducer tow cable forced a switch to the back-up cable. A subsequent problem with the back-up necessitated a return to the original tow cable which had been repaired. At one point the transducer was found to contain seawater and had to be opened up, cleaned, and repaired.

During the entire survey of the Aleutian Basin (Fig. 2; 2,487 nmi of transects) west of approximately 176° W, very little echo sign of any kind was observed. Pollock only occurred in the vicinity of haul 3 (Fig. 2), where a very light scattering layer was detected between 240 and 320 meters. This trawl yielded 286 pollock in a 3.2 hour tow. There were a number of foreign vessels in the vicinity but most did not appear to be fishing. Edward Jackowski, a Polish scientist aboard the Kaiyo Maru, contacted one of the Polish vessels in the area. He was informed

that the Polish fleet had been unable to locate any fishable pollock concentrations and that the fleet was awaiting the return of the pollock in March.

During the latter portion of Leg 1, several acoustic transects and five trawl hauls were made in the region between the Islands of Four Mountains and an area just east of Bogoslof Island. Significant quantities of pollock were observed acoustically in the 350 to 500 meter depth range. Trawl hauls made to identify the observed echo sign indicated that most of these pollock were mature but not yet spawning.

Leg 2

Aleutian Basin/Bering Sea Shelf Survey

During Leg 2, transect lines totaling approximately 2,600 nmi extended from the Aleutian Island chain to the 100 m contour line on the shelf (Fig. 3). The survey trackline proceeded eastward from about 174° W to Unimak Island. The only significant pollock echo sign in the basin was found in three high density schools located between the Islands of Four Mountains and Bogoslof Island. On February 23 and February 25, examination of fish from two trawls in this area revealed that almost all male pollock were producing milt while less than 20% of the females were producing eggs.

Pollock were encountered on the shelf on each of the transect lines. Fish were concentrated in an area near St. George Island and in an extensive aggregation northwest of Unimak Island. Densities were significant, though not as high as those observed in Bogoslof schools. Most of this shelf echo sign was contiguous with the bottom and extended approximately 40 m above bottom. In the aggregation northwest of Unimak Island, the fish ranged in size from 35 to 60 cm with an average length of 45.1 cm (Fig. 4). Of the mature females, less than 5% were readily producing eggs. Approximately half of the mature males were producing milt.

Bogoslof survey

From March 1-7, the region between 166° W and 170° 20' W was resurveyed at 10 nmi spacing (Fig. 5). The trackline mileage totalled approximately 1,000 nmi. Few fish were detected east of 167° 30' W. West of this longitude, high density concentrations of pollock were observed. Fish ranged in size from 40 to 55 cm with a mean length of 48.5 cm (Fig. 6). As in the 1988 Bogoslof survey, trawl catch sex ratios varied considerably because it was difficult to obtain a representative sample from the extremely high density schools. The percentage of females in a trawl catch ranged from a low of 42% to a high of 98%.

The maturity composition of fish in this area had changed dramatically since the first pass through in January. More than half of the female pollock had spawned, indicating that peak spawning had most likely occurred in the last few days of February or the few first days of March.

SCIENTIFIC PERSONNEL

Leg 1: January 15-February 8

Jim Traynor	Chief Scientist	AFSC
Daniel Twohig	Electronics Technician	AFSC
John Garrison	Electronics Technician	AFSC
Dave King	Gear Specialist	AFSC
Joseph Klein	Fisheries Technician	AFSC
Blaine Ebberts	Fisheries Technician	AFSC

Leg 2: February 9-March 9

Neal Williamson	Chief Scientist	AFSC
Daniel Twohig	Electronics Technician	AFSC
Taina Honkalehto	Fishery Biologist	AFSC
Jim Stark	Fishery Biologist	AFSC
Joseph Klein	Fisheries Technician	AFSC
Blaine Ebberts	Fisheries Technician	AFSC

For further information, contact Dr. Gary Stauffer, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE., BIN C15700, Building 4, Seattle, WA 98115-0070. Telephone (206) 526-4170.

Table 1. Midwater trawl station and catch data, MF89-1.

HAUL NO	DATE (1989)	TIME (AST)	START POSITION LAT. (N)	START POSITION LONG. (W)	TEMP. (C) SURF./GEAR	DEPTH (FM) FTRP./BOT.	CATCH (LBS/NOS.) WALLEYE POLLOCK	CATCH (LBS/NOS.) OTHER
1	21 JAN	0744-0833	55 31.0	165 49.7	3.3/4.5	50/68	1936/1354	234/42
2	22 JAN	2034-2215	53 53.0	175 06.4	3.2/3.7	186/2000	272/129	14/9
3	25 JAN	1503-1816	55 59.7	177 26.3	1.6/3.5	221/2000	505/286	52/35
4	06 FEB	0458-0528	53 12.1	170 26.1	3.5/3.5	197/690	873/465	36/12
5	06 FEB	2303-2348	53 29.0	168 49.1	3.6/3.6	200/844	492/285	7/2
6	07 FEB	1328-1331	53 24.9	168 51.9	3.6/3.6	235/680	486/261	16/13
7	07 FEB	1732-1738	53 50.0	168 15.3	3.7/3.6	240/861	1146/658	4/15
8	07 FEB	2142-2146	53 57.7	167 40.8	3.8/3.6	222/1900	1295/708	3/2
9	16 FEB	1207-1238	54 48.8	175 09.0	2.7/3.7	150/2000	223/122	19/19
10	17 FEB	1158-1239	58 09.6	174 13.4	2.9/3.7	226/300	595/593	58/60
11	17 FEB	1845-1907	58 48.0	173 53.8	2.6/2.5	65/68	13/12	32/13
12	17 FEB	2107-2134	58 44.1	173 55.8	2.6/2.5	60/76	4996/5147	3/8
13	21 FEB	1315-1336	56 27.3	169 18.9	2.7/3.0	56/58	23793/14985	207/35
14	23 FEB	0241-0332	53 25.0	168 49.4	3.7/3.5	199/700	1857/1068	3/2
15	25 FEB	1357-1411	53 50.9	167 41.1	3.6/3.6	253/350	3017/1457	37/84
16	26 FEB	1519-1528	55 49.2	165 54.2	2.6/2.8	62/67	2644/1857	201/-
17	27 FEB	1157-1158	55 31.4	164 53.3	2.7/2.0	54/58	978/736	39/-
18	27 FEB	2014-2017	54 55.2	164 42.8	2.7/2.4	25/35	13844/9862	156/31
19	28 FEB	1106-1111	55 16.4	163 53.1	2.4/2.1	20/35	16/12	146/16
20	28 FEB	1255-1310	55 17.6	163 52.9	2.4/2.2	33/37	271/190	983/4
21	1 MAR	0249-0251	55 44.6	165 18.7	2.8/2.6	43/50	1009/915	27/6
22	1 MAR	1230-1259	54 49.5	165 42.7	2.9/3.6	85/90	3497/1879	-
23	4 MAR	0846-0848	53 47.8	168 09.4	3.1/3.6	150/725	3329/2028	5/3
24	4 MAR	1546-1615	54 14.0	168 11.7	3.2/3.7	155/910	1018/676	-
25	5 MAR	0940-1011	53 37.4	168 43.0	3.4/3.4	116/840	35000/22204	-
26	5 MAR	1519-1520	53 40.7	168 42.3	3.5/3.4	118/900	8605/5320	-
27	6 MAR	1323-1324	53 40.4	169 17.2	3.3/3.6	144/1185	3958/2466	-

Table 2. Total catch numbers and weight by species in the 27 midwater trawl hauls from cruise MF89-1.

Species	Numbers of fish (No.)	(%)	Catch weight (lbs.)	(%)
Walleye pollock (Theragra chalcogramma)	75675	99.0	115670	98.0
Jellyfish (unidentified)	--	--	1434	1.0
Smooth lumpsucker (Aptocyclus ventricosus)	99	<0.1	375	0.3
Pacific cod (Gadus macrocephalus)	27	<0.1	322	0.3
Pacific sleeper shark (Somniosus pacificus)	1	<0.1	44	<0.1
Squid (unidentified)	8	<0.1	14	<0.1
Myctophids (Myctophidae)	246	0.3	13	<0.1
Pacific lamprey (Lampetra tridentata)	14	<0.1	12	<0.1
Rock sole (Lepidopsetta bilineata)	6	<0.1	10	<0.1
Greenland turbot (Reinhardtius hippoglossoides)	1	<0.1	4	<0.1
Pacific sandfish (Trichodon trichodon)	17	<0.1	4	<0.1
Flathead sole (Hippoglossoides elassodon)	5	<0.1	2	<0.1
Eulachon (Thaleichthys pacificus)	6	<0.1	1	<0.1
Octopus (unidentified)	2	<0.1	1	<0.1
Arrowtooth flounder (Atheresthes stomias)	2	<0.1	1	<0.1
Salmon (unidentified)	2	<0.1	1	<0.1
Viperfish (Chauliodontidae)	4	<0.1	<1	<0.1
Comb jellies (Ctenophora)	6	<0.1	<1	<0.1
Total	76121	100	117911	100

Table 3. Summary of the numbers of biological samples and measurements collected, MF891.

HAUL NO	LENGTHS	MATURITY	OTOLITHS	FISH WEIGHTS	OVARY WEIGHTS	REPROD. OVARIES	STOCK STRUCTURE FROZ.FISH	STOCK STRUCTURE OVARIES	STOMACH SCANS
1	345	300	300	100	47	47	0	0	0
2	129	100	100	100	49	49	0	0	13
3	286	100	100	100	50	0	46	0	0
4	223	100	100	100	50	50	44	0	0
5	285	150	150	100	50	0	0	50	0
6	261	100	100	100	50	0	0	0	20
7	319	100	100	100	50	0	0	0	0
8	304	0	0	0	0	0	0	0	0
9	122	88	88	0	0	0	0	49	0
10	317	266	70	0	0	0	46	35	0
11	12	0	0	0	0	0	0	0	0
12	342	141	67	67	0	0	48	0	0
13	410	107	107	107	56	0	0	0	0
14	356	102	102	102	50	0	0	0	20
15	255	87	87	87	54	0	43	0	33
16	342	110	110	110	45	0	49	45	0
17	368	113	113	113	62	0	17	0	0
18	317	109	109	109	66	0	0	0	21
19	12	0	0	0	0	0	0	0	0
20	190	87	87	87	32	0	0	0	0
21	427	102	102	102	50	0	0	0	0
22	274	91	91	91	49	0	48	0	0
23	321	64	64	64	50	0	33	0	20
24	261	50	50	50	45	0	9	0	0
25	295	97	97	97	38	0	10	0	0
26	285	100	0	0	0	0	0	0	0
27	296	58	58	58	50	0	0	0	0
TOTAL	7354	2722	2352	1944	993	146	393	179	127

Table 4. Inventory of CTD casts, MF89-1. Start position longitudes are defined as west (+) or east (-).

HAUL NO	CAST NO	DATE (1989)	TIME (AST)	START POSITION LAT (N)	LONG.	DEPTH (m)	COMMENT
0	6	89 1 18	1540	5339.5	16650.8	80	CALIBRATION
1	7	89 1 21	1027	5530.4	16545.8	120	HAUL
2	8	89 1 23	0004	5358.9	17458.1	3700	HAUL
0	9	89 1 23	0941	5322.6	17800.3	3700	TRANSECT 1 S.
3	10	89 1 25	1936	5608.4	17723.7	3700	HAUL
0	11	89 1 26	1346	5703.5	17651.8	3600	TRANSECT 1 N.
0	12	89 1 26	2119	5703.3	17915.4	3800	TRANSECT 2 N.
0	13	89 1 27	2033	5315.2	17935.1	2700	TRANSECT 2 S.
0	14	89 1 28	0539	5315.6	17710.1	3800	TRANSECT 3 S.
0	15	89 1 31	1551	5302.7	-17442.6	4000	TRANSECT 4 S.
0	16	89 2 01	1744	5730.4	-17603.0	3700	TRANSECT 4 N.
0	17	89 2 02	0318	5730.2	-17830.6	3700	TRANSECT 5 N.
0	18	89 2 02	2036	5437.9	-17733.7	3700	BAD DROP
4	19	89 2 06	0712	5312.4	17022.0	1300	HAUL
5	20	89 2 07	0029	5329.3	16848.8	1500	HAUL
7	21	89 2 07	1839	5349.2	16817.9	1600	HAUL
0	22	89 2 12	2145	5338.8	16846.3	1600	INTERCALIBRATION
0	23	89 2 13	2008	5339.4	16650.6	80	CALIBRATION
0	24	89 2 15	1738	5229.8	17548.3	3500	LINE 20 S.
9	25	89 2 16	1323	5439.3	17512.5	3600	HAUL
10	26	89 2 17	1313	5806.4	17411.2	1000	HAUL
12	27	89 2 17	2217	5849.2	17355.1	140	HAUL
0	28	89 2 19	1932	5248.5	17319.4	1560	LINE 14 S.
0	29	89 2 20	2332	5604.5	17039.8	1850	LINE 11 SLOPE
13	30	89 2 21	1120	5627.2	16917.5	110	HAUL
14	31	89 2 23	0418	5326.5	16844.7	900	HAUL
0	32	89 2 25	0526	5444.3	16724.4	550	LINE 5 SLOPE
15	33	89 2 25	1553	5352.1	16741.6	1580	HAUL
16	34	89 2 26	1626	5549.2	16551.5	120	HAUL
17	35	89 2 27	1314	5531.6	16453.4	110	HAUL
18	36	89 2 27	2128	5454.3	16448.5	80	HAUL
20	37	89 2 28	1417	5518.4	16353.5	70	HAUL
21	38	89 3 01	0402	5544.7	16518.9	110	HAUL
22	39	89 3 01	1345	5448.2	16542.7	170	HAUL
23	40	89 3 04	1015	5349.2	16807.5	1430	HAUL
24	41	89 3 04	1852	5415.5	16813.0	1650	HAUL
26	42	89 3 05	1653	5340.1	16846.2	1600	HAUL
27	43	89 3 06	1453	5339.5	16919.7	2300	HAUL
0	44	89 3 08	1740	5339.4	16650.7	110	CALIBRATION

Table 5. Inventory of XBT casts, MF89-1. Start position longitudes are defined as west (+) or east (-).

CAST NO	HAUL NO	DATE	TIME (AST)	START POSITION LAT. (N)	LONG.	DEPTH (m)	COMMENT
1	0	89 1 13	0021	5812.0	13904.0	1500	CALIBRATION
2	0	89 1 13	1645	5811.5	14513.7	3950	
3	0	89 1 14	0546	5753.3	14938.5	203	
4	0	89 1 23	0118	5402.8	17404.0	4000	
5	0	89 1 23	1654	5327.4	17732.0	4000	
6	0	89 1 24	2325	5505.7	17654.1	3700	
7	3	89 1 25	2214	5605.0	17713.0	3650	HAUL
8	0	89 1 27	0655	5700.9	17914.9	3660	
9	0	89 1 28	0501	5314.2	17935.0	2654	
10	0	89 1 28	1410	5315.4	17710.6	3600	
11	0	89 1 31	1940	5302.5	-17320.6	1280	
12	0	89 2 01	0009	5302.6	-17441.3	3843	
13	0	89 2 02	0216	5728.0	-17601.0	3660	
14	0	89 2 02	1145	5730.1	-17830.0	3700	
15	0	89 2 03	0506	5438.5	-17734.3	2000	
16	0	89 2 05	0008	5401.5	17537.0	3650	
17	0	89 2 06	0045	5325.6	17320.8	3300	
18	4	89 2 06	1531	5312.0	17021.7	1281	HAUL
19	5	89 2 07	0650	5329.1	16847.8	340	HAUL
20	7	89 2 08	0309	5349.4	16816.4	1576	HAUL
21	8	89 2 08	0719	5357.7	16742.6	1410	HAUL
22	0	89 2 13	0610	5338.3	16846.3	1550	
23	0	89 2 15	0533	5331.1	16911.4	2020	
24	0	89 2 15	1642	5300.6	17240.0	2030	
25	0	89 2 16	0155	5231.0	17543.0	3350	
26	9	89 2 16	1704	5454.0	17508.0	3660	HAUL
27	10	89 2 17	1909	5811.9	17414.7	550	HAUL
28	0	89 2 20	0421	5254.0	17316.4	1700	
29	0	89 2 21	0800	5604.3	17039.2	1650	
30	0	89 2 22	0540	5522.0	16940.0	2150	
31	14	89 2 23	1228	5326.8	16846.9	1300	HAUL
32	0	89 2 25	0458	5444.0	16724.3	560	
33	0	89 2 25	0930	5407.6	16734.3	1775	
34	0	89 2 26	1026	5421.6	16616.4	670	
35	0	89 2 27	1732	5556.7	16442.3	100	
36	0	89 2 28	1327	5553.0	16400.0	93	
37	0	89 3 01	0350	5555.0	16440.5	95	
38	0	89 3 03	0825	5426.1	16702.1	555	
39	0	89 3 04	0150	5427.8	16744.3	908	
40	0	89 3 05	0644	5430.4	16820.4	1536	
41	0	89 3 06	0646	5407.5	16854.1	2195	
42	0	89 3 07	0653	5348.4	16933.2	1900	
43	0	89 3 08	0320	5400.8	17007.0	2030	

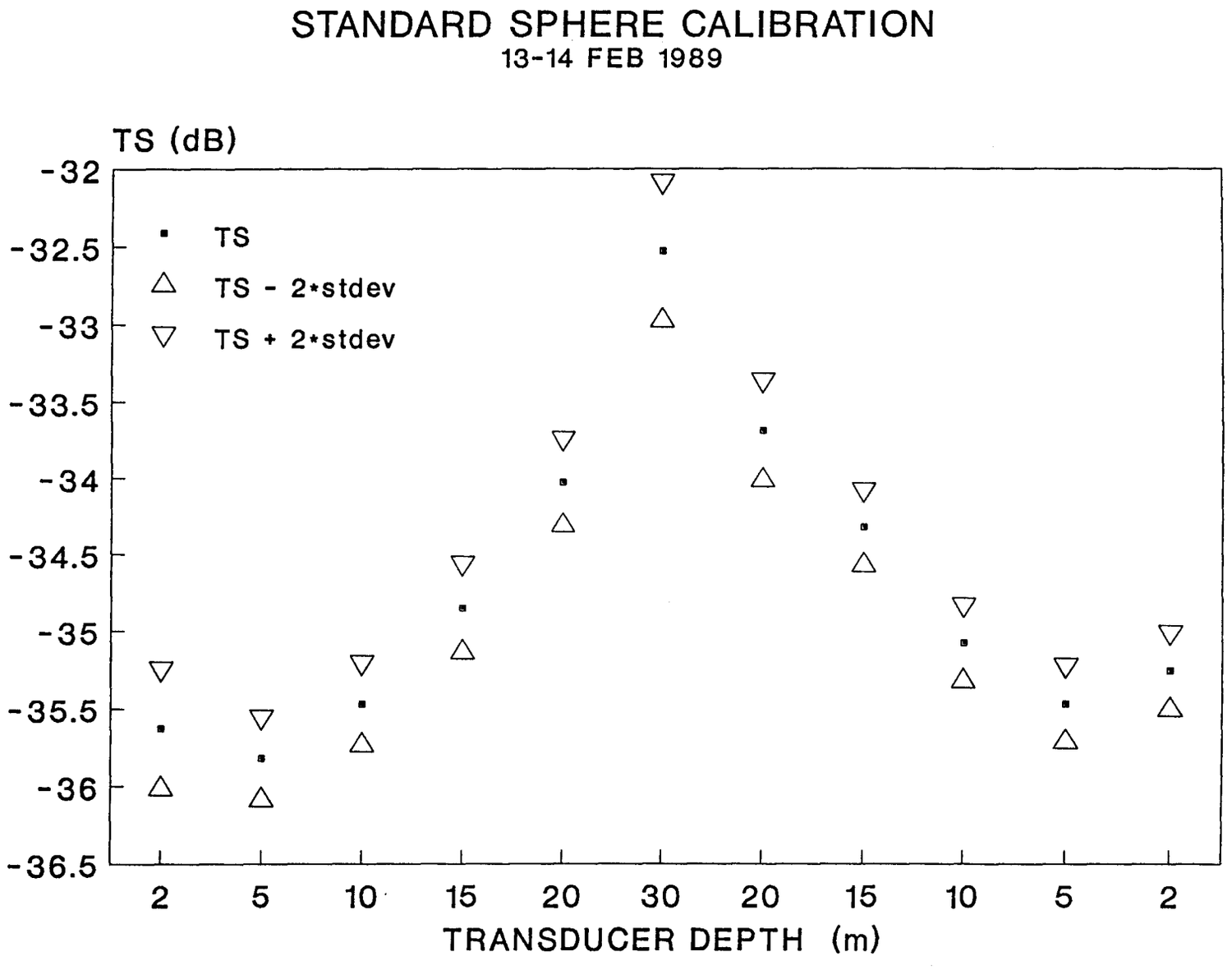

Fig. 1. Target strength (dB) of a standard copper sphere at selected transducer depths between 2 and 30 m. Transducer was first lowered from 2 m to 30 m, then raised to its original position at 2 m. The theoretical target strength of the sphere is -33.7 dB.

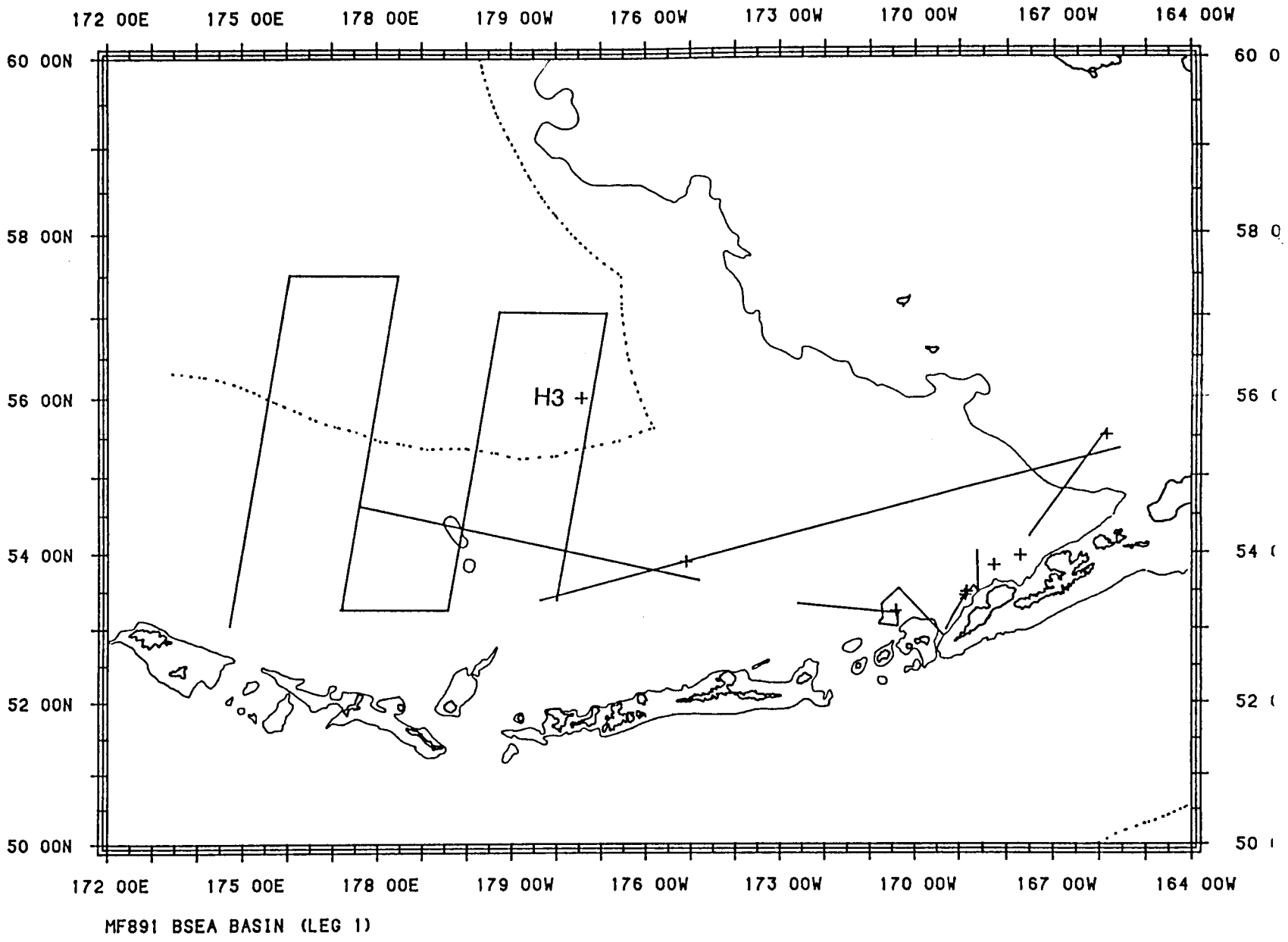

Fig. 2. Aleutian Basin survey (Leg 1) trackline (straight, solid lines) and midwater trawl stations (+), MF89-1. H3 indicates the location of haul 3, referred to in the test.

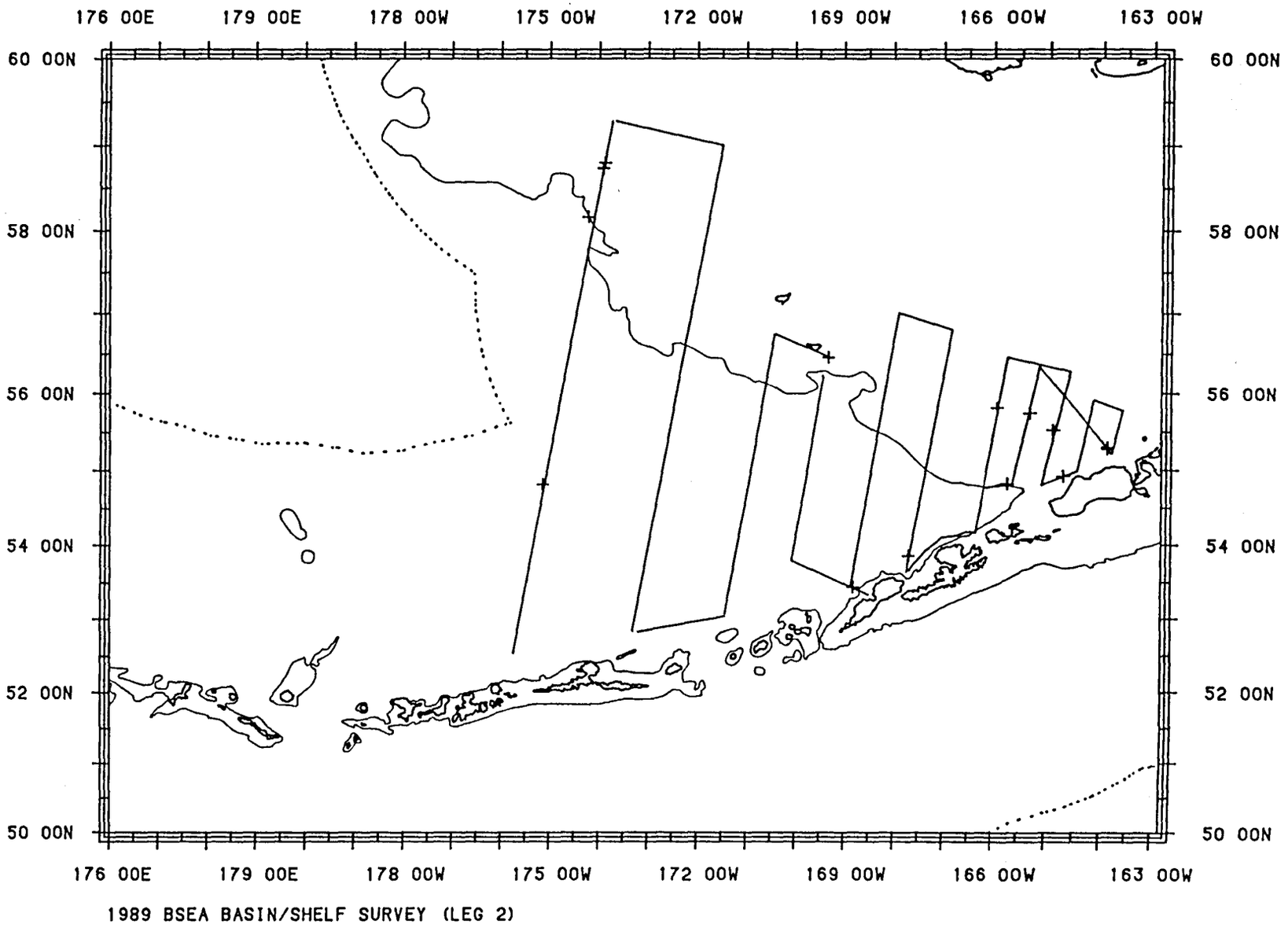

Fig. 3. Aleutian Basin survey (Leg 2) trackline (straight, solid lines) and midwater trawl stations (+), MF89-1.

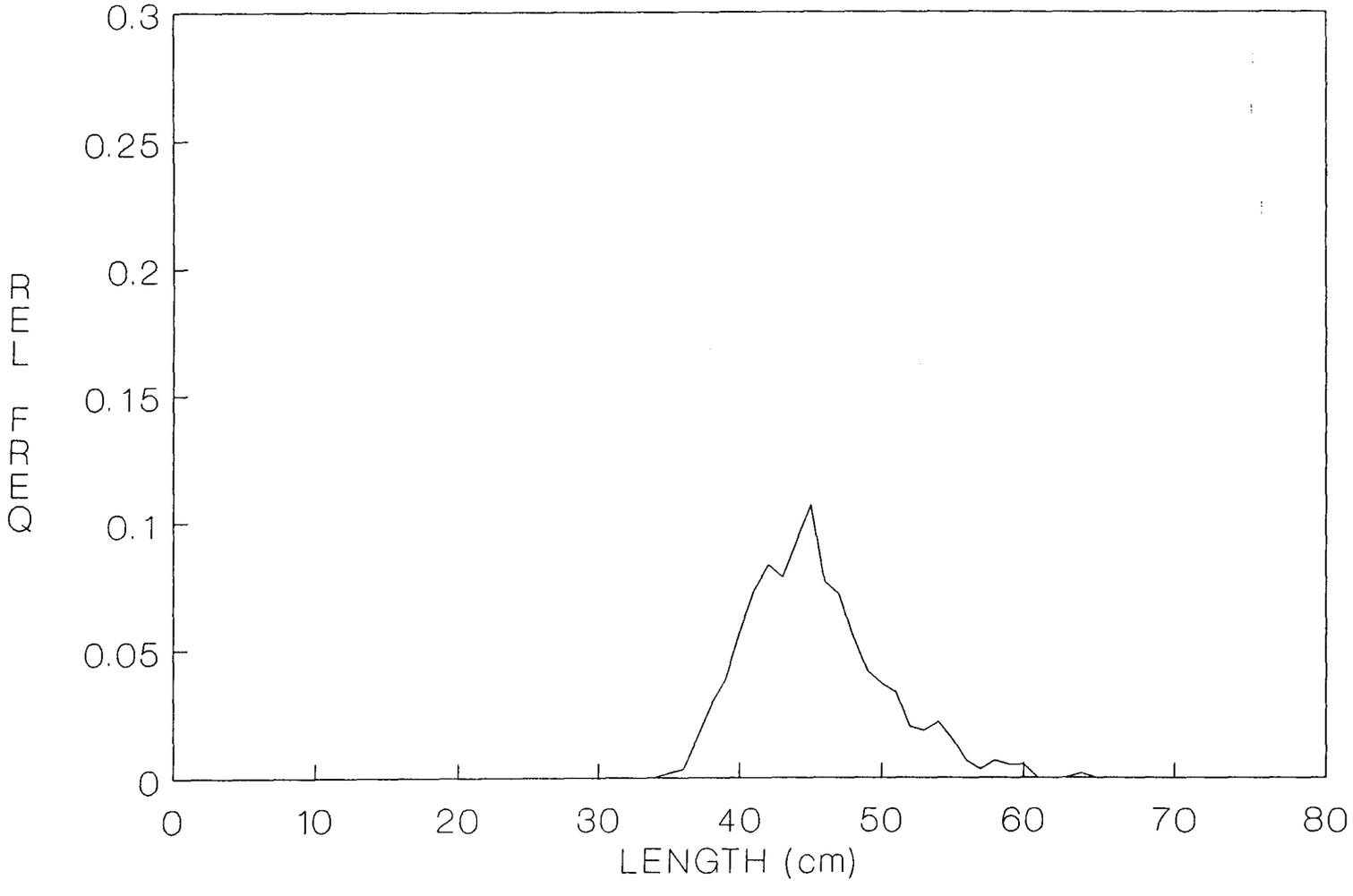

Fig. 4. Pollock length distributions from midwater trawl samples (unweighted by population size) in the southeast Bering Sea shelf region, MF89-1.

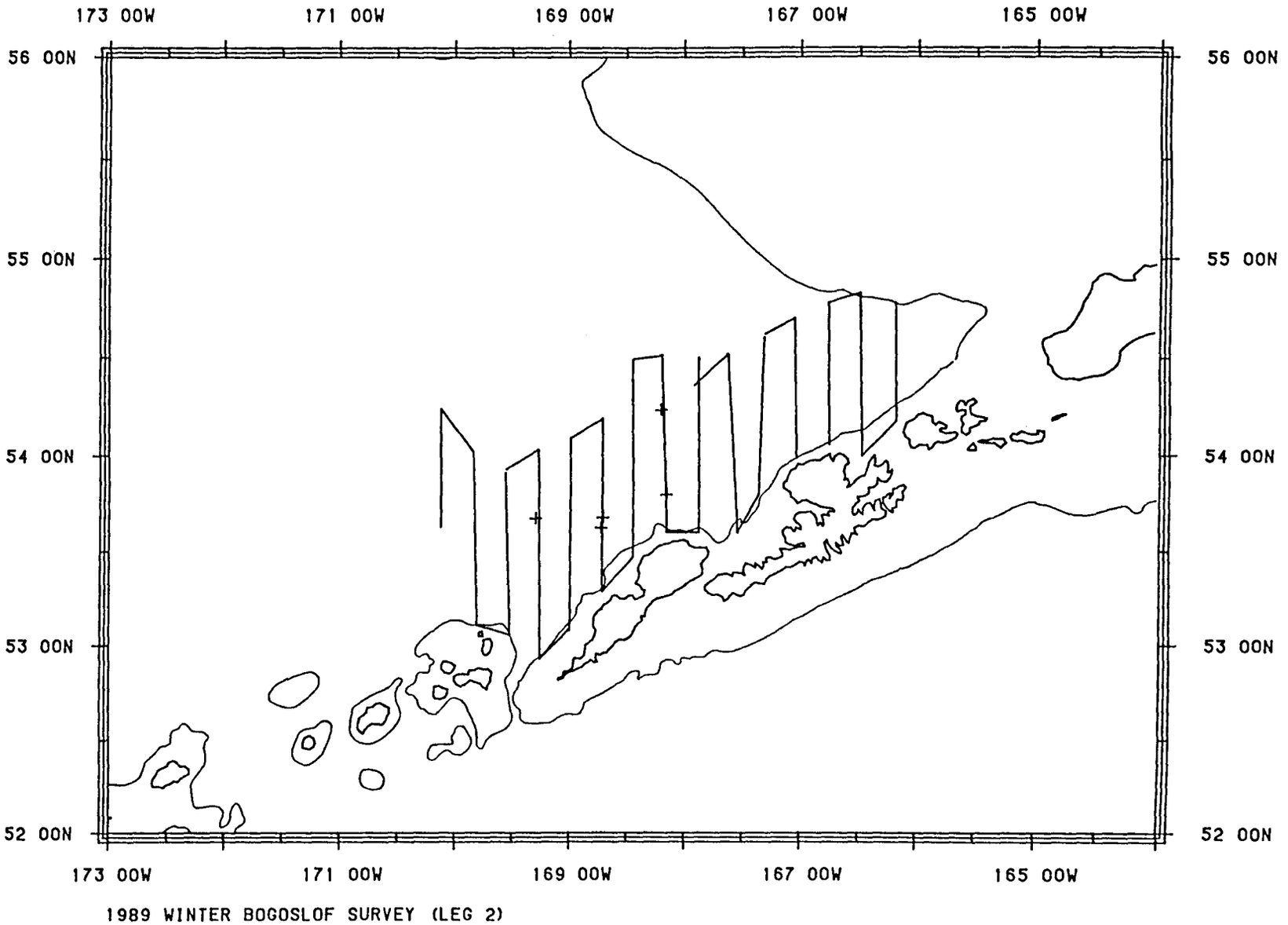

Fig. 5. Bogoslof survey (Leg 2) trackline (straight, solid lines) and midwater trawl stations (+), MF89-1.

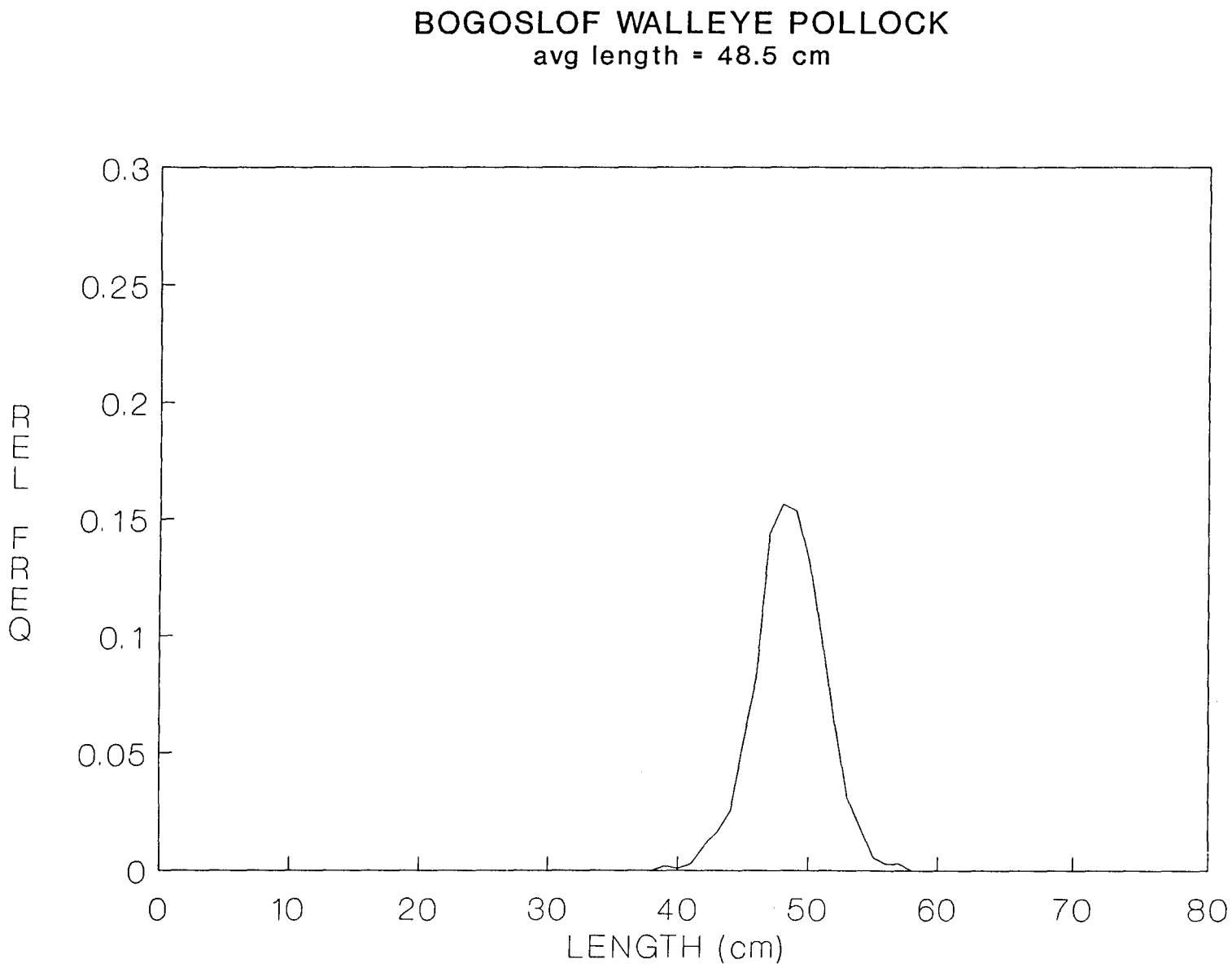

Fig. 6. Pollock length distributions from midwater trawl samples (unweighted by population size) in the Bogoslof Island region, MF89-1.